

Preparation for Emergency Relief after Biological Warfare

R. Steffen^{*1}, J. Melling^{†2}, J. P. Woodall³, P. E. Rollin⁴, R. H. Lang⁵, R. Lüthy⁶
and A. Waldvogel⁷

¹Institute of Social and Preventive Medicine, University of Zurich, Switzerland, ²Centre for Applied Microbiology, Porton Down, Salisbury, Wiltshire SP4 0JG, U.K., ³New York State Health Department, New York, U.S.A., ⁴Centers for Disease Control and Prevention, Special Pathogens Branch, Atlanta, GA, U.S.A., ⁵Institute of Pathology, University of Berne, Switzerland, ⁶Division of Infectious Diseases, Zurich University Hospital, Zurich, Switzerland and ⁷Institute for Veterinary Pathology, University of Zurich, Switzerland

Accepted for publication 19 September 1996

Upon invitation by the World Health Organization during the Gulf War, a task force "Scorpio" independent from the nations involved in the armed conflict was formed whose task was to determine whether, which and to what extent biological warfare agents had been used. Risk assessment concluded that anthrax and Clostridium botulinum toxin were the major risks. The 21 civilian experts had rapidly to decide on the doctrine of operation, to assemble material which could be used and to be immunized or protected otherwise against the potential risks.

Biological warfare agents may be used anywhere any time, be it by terrorists or during open or clandestine hostilities. The general population cannot rely on the military to take care of civilian relief, thus international and national organizations may wish to establish similar task forces basing on the "Scorpio" model on a national or regional basis.

Introduction

After the occupation of Kuwait on August 2, 1990, Iraq threatened to use biological weapons in a subsequent war. Additionally, the possibility of a biological accident had to be considered in the conflict. Six years later there is continued and even increasing concern[‡] about the proliferation of biological weapons despite the attempt of many countries to control the export of related equipment and materials. Since biological weapons require less sophisticated technology than their nuclear and chemical counterparts it therefore remains important to prepare for even a limited use of such weapons.

If biological weapons were to be used, the civilian as well as the military population would be at considerable risk and therefore there would be a real need for specialist expertise separate from any military operations to alleviate civilian casualties. During the countdown to the Gulf war, a need was seen by the World Health Organization (WHO) to prepare for a potential threat posed

by weapons of mass destruction to civilians in the area. The specific threats mentioned at the time were chemical and biological. While means of protection against and decontamination after chemical attack were fairly well understood from experience in previous wars, there was no such experience regarding the possible effects of an attack with the agents of anthrax or botulism, which were the most frequently referred to. It was foreseen that relief personnel to arrive on the spot after a biological attack would need information and all the protection available, including protective clothing and equipment, prophylactic vaccination and antibiotics.

Political considerations demanded that any quick reaction investigation team would have to be neutral to ensure acceptance. WHO made contact and subsequently the Swiss Disaster Relief Unit (SDR) with its outstanding record of relief in disasters all over the world was invited to offer support. Thus Task Force "Scorpio" came into being. The Secretary General of the United Nations was informed by WHO when "Scorpio" was ready.

Objectives

The objectives of "Scorpio" were envisaged to be to — investigate whether biological weapons (BW) had been used or spilled, and to identify them.

* Address correspondence to: Prof. Robert Steffen, ISPM, Sumatrastrasse 30, CH-8006 Zürich, Switzerland.

† Present address: The Salk Institute for Biological Studies, Swiftwater, PA, U.S.A.

‡ Ekéus R. *Seminar on CBW Verification*. 5th International Symposium on Protection Against Chemical and Biological Warfare Agents, Stockholm, 10–11 June 1995.

- assess the risks for the local civilian populations.
- ascertain the risk to which relief organizations reaching the area would be exposed.
- provide preliminary advice and recommendations to the local administrative and health authorities and to relief organizations.

To attain the first objective, properly protected specialists would collect pathological samples from victims, and environmental samples, to be examined on the spot and then, if necessary, transmitted to reference laboratories for further analysis.

The second and third objectives would be achieved by an epidemiological survey and analysis of the local situation, in the light of the clinical and laboratory findings. A particular concern would be residual contamination of materials, land and buildings and the decontamination necessary to render the area safe.

The fourth objective would be reached by analysing the entire situation and devising a plan for population treatment and relief based on the best medical and scientific knowledge.

Risk Assessment

A lot of learning had to be done initially. Obviously, as the nucleus of the Task Force was to be composed of citizens of Switzerland, which is not a member of the United Nations and was not involved in the Gulf conflict, the relevant classified information from those involved in the Gulf War was not readily available. Nevertheless, mainly through personal contacts it was possible to establish the potential biological warfare risks listed in Table I in the short time available.

It was generally assumed that bacteriological agents or toxins might well be used. Whereas it was uncertain whether they could be included in missiles or grenades, terrorist or commando attacks for such purpose remained a definite risk. In contrast, the capability to prepare viral agents for biological weapons by any country in the area seemed unlikely, but this risk could not be entirely excluded. Additionally, Iraq had previously demonstrated its will and ability to use chemical weapons. None of our contacts assumed that nuclear weapons would be used in the conflict, but nuclear spillage by sabotage or after bombing nuclear plants seemed a real possibility.

Personnel

A team of 21 people was assembled for "Scorpio". This included nine medical experts: an epidemiologist who was also a preventive medicine specialist, an infectious

disease specialist, a microbiologist expert in bacteria and toxins, a virologist, one human and two veterinary pathologists, and two medical relief operations specialists. Two experts on chemical and nuclear weapons, with specialized equipment, were included to detect an attack with mixed weapons. Finally there were 10 co-ordinators, who included radio and logistics experts and flight dispatchers.

Veterinary pathologists were included, since animals provide a most valuable source for obtaining diagnostic samples, particularly in countries where autopsies of humans are refused for religious reasons. Animals are also susceptible to an infection with *Bacillus anthracis* and to the effects of botulinus toxin. Anthrax infection is usually brief and septicaemic in ruminants; in horses, pigs and goats it is frequently localized to the throat or intestine and may become fatal before invasion of the cardiovascular system has occurred.^{1,2}

Equipment

Each volunteer was equipped with the conventional equipment of the Swiss Disaster Relief Unit, sufficient food and water for 12 h and protection gear against nuclear, chemical and biological weapons.

Each expert prepared his own special material. Of particular interest were the anthrax kit (Table II), the equipment to perform autoptic investigations, and the virology equipment. This consisted of ELISA reagents (microtitre plates, mostly lyophilized antigens and buffers). Other equipment included incubators (optional for the tropics), a microplate washer, a microplate reader and a nitrogen tank to freeze the specimens collected for reassessment in the reference laboratories and other centres. The goal was to be able to detect antigens, IgM and IgG in serum, blood and/or other human and/or animal collected specimens. The range of pathogenic agents to be investigated included haemorrhagic fever viruses (Crimean-Congo, Lassa, Rift Valley fever, Ebola, Marburg, Bolivian, Argentinian, haemorrhagic fever with renal syndrome) and arboviruses (Yellow fever, Venezuelan equine encephalitis, sandfly fevers and tick-borne encephalitis).

Additionally, standard material to investigate chemical agents and radioactivity were included. The Swiss Disaster Relief Unit supplied its general support pharmacy kit. The total weight of this material was slightly less than 1 ton.

Doctrine of Operation

All volunteers remained on stand-by during the critical phase of the Gulf War. Important elements of the team

Table I. Potential risks for Task Force "Scorpio" and preventive measures.

Vaccine/Ig	Risk	Immunization schedule					Responders by February 1991*
		d1	d14-21	d28-35	dx	Additional protection	
<i>Preventive measures performed 1990/91</i>							
Biological natural risks							
Poliomyelitis (Salk)	(+)	—	+	—	—	—	
Tetanus-Diphtheria	(+)	—	+	—	—	—	
Hepatitis A (Ig)	+	—	—	—	+	—	
Hepatitis B	+	+	+	+	—	—	
Typhoid (Ty 21 a)	+	d1,3,5	—	—	—	Antibiotics	
Meningococcus	+	+	—	—	—	Antibiotics	
(Rabies)	(+)	—	—	—	—	PEP	
Biological warfare risks							
Anthrax	++	+	+	+	—	Antibiotics	17/21
Botulin (Ig)	++	—	—	—	+	—	
Cholera	+	+	—	—	—	—	
Q-fever	(+)	—	—	—	—	PEP	
Plague	+	—	—	—	—	PEP	
Smallpox	(+)	—	—	P/ND	—	—	
Tularaemia	+	+	—	—	—	Antibiotics	18/21
VEE	—	—	+	—	—	—	20/21
<i>Additional vaccines recommended 1996</i>							
Botulism	++	+	+	3 m!	Booster 12 m	—	
Hepatitis A active (1440 EL.U)	+	+	—	—	—	Booster 6 m	
Rabies	+	+	d7	+	—	PEP	
Yellow fever	(+)	+	—	—	—	—	

+ = for all (unless documented immunity); dx = immediately before departure; PEP = postexposure prophylaxis; P/ND = planned, not done; m = month(s).

*at the time "Scorpio" thought to be ready (February 1991).

++ = definite possibility of use in biological warfare.

+ = possible risk, in biological warfare or natural risk.

(+) = unlikely risk, in biological warfare or natural risk.

would have been able to leave from Zurich within 12 h. However, in view of the professional commitments of the experts the complete team could not be guaranteed within less than 48 h.

It was planned to actually deploy a team of 8-16 persons, landing with a Red Cross ambulance jet to the nearest airport outside the disaster area. From there, those necessary according to the circumstances would proceed overland. Human or animal tissues and environmental specimens would have been collected and examined by the relevant experts in the team. If possible, the initial microbiological, chemical and nuclear analysis, expected to last no longer than 48-72 h, would be conducted not at the site of the disaster, but at the airport. Meanwhile, based on a hypothesis as to which pathogenic agents might have been used, the epidemiologist would have determined the geographical extent of the problem. After this period it was expected that most of the specialists could be withdrawn, leaving medical and epidemiological personnel necessary to co-ordinate the local authorities

and relief teams. Since there was no request for deployment of the task force during the entire Gulf War, its members remained in Europe.

Protective Measures for the Task Force

Owing to the nature of their professional work, specialist personnel had already been immunized against some of the possible biological agents and/or natural biological hazards. It was necessary, however, to provide further immunizations to both specialist and non-specialist personnel to ensure, as far as possible, uniformity of protection. The details of the immunization program and immune responses are shown in Table I. It was appreciated that immunization alone was unlikely to have provided sufficient protection against some of the possible biological hazards and accordingly chemoprophylaxis/chemotherapy would have been an important component. Two broad spectrum antibiotics, ciprofloxacin and doxycycline would have been the first choice.

Table II. Anthrax "kit".

Microscopy	Culture	Support materials
Microscope*	Nutrient agar‡	Labels
Immersion oil	Plet agar‡	Parafilm
Slides	Loops	Gloves
Coverslips	Penicillin discs‡	Syringes 2, 5, 10, 50 ml
Staining rack	Phage‡	.45 and .22 µm filters
Staining try	Mini-slants	Autoclave tape
Wash bottle	Mailing cans	Mailing materials
M'Fadyean stain	Specimen pots (20)	Jiffy bags
Paper towel	Sterile water (500 ml)	Magic markers
Loops	Sterile containers	Coolbox
Ethanol†	(Universals, 30)	Swabs
Pipettes	Water bath*	Refrigerator*
Lens paper	Thermometer	Matches
Slide holders	Incubator*	Freezer packs
Blood (Tissue Culture Services Horse Blood)‡	25–250 u. pipette	
Screw-cap bottles 10 ml (20)	Tips for pipette	
Racks	1 and 10 ml pipettes	
	Pressure cooker*	
	Autoclave bags	
	Bunsen/gas ring†	
	Spreaders	
	Disposal jars (3)	
	Hypochlorite tablets	
	Sterile tongue blades	
	Pipette bulbs	
	Universal racks	
	Tweezers	
	100 ml bottles (5)	

* Bulky or costly or problematic if electricity not available.

† Flammable; subject to air transport regulations. Try to have available on site.

‡ Perishable.

As mentioned, two biological agents were of most concern, *B. anthracis* and *Clostridium botulinum* toxin. Anthrax vaccination has been reported to provide a protection rate in humans of 92.5% under circumstances likely to be encountered in practice.^{3,4} Prophylactic antibiotics, according to the available information at the time, suggested that they offered less complete protection.⁵ More recent studies in monkeys on ciprofloxacin or doxycycline offer protection estimated to be in the order of 90%.^{6,7} The strain used, however, in these experiments (Vollun 1B) is not the most virulent and the protection level may be less against other strains. It was decided that the Task Force would be protected by both vaccine and antibiotics as this seemed likely to have an additive effect. In addition, antibiotic cover could protect against BW agents other than those mentioned above.

However, anthrax vaccine was only produced in England and in the United States and understandably the entire production was initially reserved for the coalition troops. It was only on 17 January 1991 that the British Government granted an export licence for supplies to the Task Force, which was then immediately immunized

according to the schedule shown in Table I. At the time no active botulinum, plaque and rabies vaccination was performed either due to lack of time, or due to lack of priority. Yellow fever was not considered a risk.

Fortunately one member of the Task Force, having previously been vaccinated against botulinum toxins, a process which required 1 year, and who had sufficient antibody titre, volunteered to donate blood for plasmapheresis. Subsequently, 24 portions of 15 ml immune globulin were prepared which would have been injected intramuscularly immediately before the mission of the Task Force. It was calculated that this would give protection against any likely exposure. Protection would probably be maintained for some 12 weeks.

The Task Force was also immunized against Venezuelan Equine Encephalitis (VEE) by a live attenuated TC-83 vaccine and tularaemia by the live attenuated LVS strains vaccine. Both were obtained from the United States Army Medical Research Institute for Infectious Diseases (USAMRID). These vaccines are thought to offer high protection rates.⁸ As some competent sources strongly recommended vaccination against cholera, this advice was followed although the old parenteral vaccine was

known to have an efficacy limited to 50%, whereas newer vaccines are more effective.⁹

The immunizations were well tolerated. Three of the four live vaccines (typhoid, tularaemia, VEE, yellow fever) have been given on day 1 of the immunization course. Some fever, chills and malaise was only observed a few days after the second session, when one-third of the volunteers became incapable of working for up to 3 days. This was attributed to the VEE vaccine. The Task Force was considered sufficiently protected and reported to the UN as operational by 19 February 1991; the ground war started on 28 February. The volunteers were bled on 28 February and the proportion with antibodies is shown in Table I.

Discussion and Conclusions

Biological weapons are known to have been produced until 1992 even in countries having signed the 1972 Biologicals and Toxin Weapons Convention.¹⁰ A number of countries almost certainly still retain such capability and it is perceived to be an option which could be favoured by less developed countries. In the present circumstances there is a clear need to have available task forces capable of responding as an adjunct to civil disaster relief in the event that weapons of mass destruction (especially biological and chemical) are deployed in future conflicts. Civil relief operations would be unwise to rely only on military expertise which in the event of such conflicts could be unavailable or could compromise the acceptability of these operations. As has been frequently observed until recently, military command structures in national¹¹ and international¹² contingents by setting different priorities often compromise a mission by neglecting medical needs. However, many of the experts will need to be recruited from military sources.

Presently, a more detailed evaluation of potential agents and appropriate medical counter measures is possible and necessary. In 1996, anthrax spores remain the main biological risk, with *C. botulinum* toxin also considered a major risk. Neither agent can be transmitted from person to person. Other bacteriological agents and toxins are also considered as hazards to relief workers, as they could well be diagnosed and treated in time and are not as persistent in the environment.

The major risks for relief workers are likely to arise from (1) transmission of disease from populations infected in a primary attack, and (2) exposure to agents persisting in the environment in the form of secondary aerosol inhalation and the contamination of wounds or abrasions. The biological agent risk for relief workers may differ from that experienced by populations exposed to a

primary attack, because the concentration of agents is likely to be low by the time of the arrival of relief workers. However, with the possibility of further attacks, the necessary protection should also be made available to relief workers.

Subsequently evaluation indicated that the overall Task Force composition was qualitatively correct in comprising biological, chemical, nuclear and logistic capabilities. However, the chemical and nuclear component was deliberately limited. Had weapons of mass destruction been used, the likelihood was that these would have been biological or chemical or a combination thereof. In such circumstances effective and safe operation of the Task Force might have required the mutual support and expertise of the biological and additional chemical and nuclear specialists. The lesson is therefore that a Task Force should consist of specialist cores of biological, chemical (or even nuclear) specialists supported by common logistics, e.g. transport, radio.

Emergency preparedness for a BW attack is a complex and time-consuming matter. For example a full series of vaccinations takes at least 3 months, and in some cases up to 1 year. It is time consuming to assemble the equipment. Also, a training period of up to 1 week seems necessary to ensure continued familiarization with protective equipment and to maintain a co-ordinated operational effectiveness. Regular refresher courses are necessary.

The experience in 1990/91 indicates that prospective members of such a Task Force should maintain an immunization coverage for the most likely biological hazards included in Table I. The immunization list satisfies the needs on the basis of recent information from Russia.¹⁰ If the Task Force would have been called into action, the levels of protection of many of its members would have been barely sufficient because of the time constraints. In addition, a database needs to be established and maintained covering antibiotic resistance of the relevant agents concerning natural disease and where possible of biological agents.

Conventional relief teams have not been trained to take samples, work in protective clothing, decontaminate people and property, and above all, have not had the long series of vaccinations and boosters needed to protect them. A BW attack may come at any time, be it by a terrorist act or during open hostilities. Since after a BW attack the general population may not be able to rely on the military to take care of civilian relief when they will be fully occupied with their own problems, it is worth considering whether one Task Force "Scorpio" is sufficient or whether using this initial model groups of countries might wish to establish a similar capability.

References

- 1 Carman JA, Hambleton P, Melling J. *Bacillus anthracis*. *Soc Appl Bact Tech Soc* 1985; **21**: 207–214.
- 2 Valli VEO. The hematopoietic system. In: Jubb KVF, Kennedy PC, Palmer N, eds. *Pathology of domestic animals*, 4th ed., vol 3. San Diego: Academic Press, 1993: 101–265.
- 3 Brachmann PS *et al.* Field evaluation of a human anthrax vaccine. *American Publ Health* 1962; **52**: 632–645.
- 4 Hambleton P, Carman JA, Melling J. Anthrax: the disease in relation to vaccines. *Vaccine* 1984; **2**: 125–132.
- 5 Gochenour WS, Gleiser CA, Tigertt WD. Observation on penicillin prophylaxis of experimental inhalation anthrax in the monkey. *J Hyg Camb* 1962; **60**: 29–33.
- 6 Friedlander AM *et al.* Postexposure prophylaxis against experimental inhalation anthrax. *J Infect Dis* 1993; **167**: 1239–1242.
- 7 Turnbull PCB *et al.* Antibodies to anthrax toxin in humans and guinea pigs and their relevance to protective immunity. *Med Microbiol Immunol* 1988; **177**: 293–303.
- 8 Burke DS. Immunization against tularemia: Analysis of effectiveness of live *Francisella tularensis* vaccine in prevention of laboratory-acquired tularemia. *J Infect Dis* 1977; **135**: 55–60.
- 9 Levine MM, Kaper JB. Live oral vaccines against cholera: an update. *Vaccine* 1993; **11**: 207–212.
- 10 Adams J. *The new spies*. London: Hutchinson, 1994: 270–283.
- 11 Desfontaine M *et al.* Impact des moustiquaires imprégnées sur la transmission palustre. Abstract, *Première Journée Française de Médecine des Voyages*, Paris 1994, p. 60.
- 12 Steffen R, Woodall JP, Nagel J, Desaulles M. Evaluation of Immunization Policies for Peacekeeping Missions. *Int J Technology Assessment in Health Care* 1991; **7**: 354–360.